

What is claimed is:

1. An optical system comprising:

(A) a microdisplay; and

(B) a magnifier for producing a magnified image of the microdisplay for viewing by a human eye, said magnifier having a focal length f_0 , a long conjugate side in the direction of the human eye, a short conjugate side in the direction of the microdisplay, and an f-number $f\#$ for light passing from the long conjugate to the short conjugate, said magnifier, in order from the long conjugate side to the short conjugate side, comprising:

(I) a first element having a first surface which is convex in the direction of the long conjugate, said first element having a focal length f_1 ;

(II) a block of optical material; and

(III) a second element having a second surface which is convex in the direction of the short conjugate, said second element having a focal length f_2 ;

wherein:

(a) $f_1 > 0$;

(b) $f_2 > 0$;

(c) the first surface is a diffractive surface, or the second surface is a diffractive surface, or the magnifier comprises a diffractive surface which is separate from the first and second surfaces;

(d) axial light passing through the optical system from the long conjugate to the short conjugate and converging at the microdisplay has a beam diameter at the diffractive surface whose maximum value is d ; and

(e) the beam diameter value d , the focal length f_0 , and the f-number satisfy the relationship:

$$(f\# \cdot d)/f_0 > 0.4.$$

2. The optical system of Claim 1 wherein the beam diameter value d , the focal length f_0 , and the f-number satisfy the relationship:

$$(f\# \cdot d)/f_0 > 0.8.$$

3. The optical system of Claim 1 wherein:

$$f_1/f_2 > 1.0.$$

4. The optical system of Claim 1 wherein:

$$f_1/f_0 > 1.3.$$

5. The optical system of Claim 1 wherein:

$$f_1/f_2 > 1.0; \text{ and}$$

$$f_1/f_0 > 1.3.$$

6. The optical system of Claim 1 wherein the diffractive surface is closer to the magnifier's long conjugate side than to its short conjugate side.

7. The optical system of Claim 6 wherein the first surface is the diffractive surface.

8. The optical system of Claim 7 wherein the first surface is both diffractive and aspheric.

9. The optical system of Claim 1 wherein the first and second surfaces are aspheric.

10. The optical system of Claim 1 wherein the magnifier is telecentric on its short conjugate side.

11. The optical system of Claim 1 wherein the first element, the block of optical material, and the second element are molded as one solid piece.

12. The optical system of Claim 1 wherein the optical path through the block of optical material is folded.

13. The optical system of Claim 1 wherein the distance T between the first and second surfaces satisfies the relationship:

$$30 \text{ millimeters} \leq T \leq 45 \text{ millimeters}.$$

14. An optical system comprising:

(A) a microdisplay; and

(B) a magnifier for producing a magnified image of the microdisplay for viewing by a human eye, said magnifier having a focal length f_0 , a long conjugate side in the direction of the human eye, and a short conjugate side in the direction of the microdisplay, said magnifier, in order from the long conjugate side to the short conjugate side, comprising:

(I) a first element having a first surface which is convex in the direction of the long conjugate, said first element having a focal length f_1 ;

(II) a block of optical material; and
(III) a second element having a second surface which is convex in the direction of the short conjugate, said second element having a focal length f_2 ;

wherein:

5 (a) $f_1 > 0$;
(b) $f_2 > 0$;
(c) $f_1/f_2 > 1.0$; and
(d) the first surface is a diffractive surface, or the second surface is a diffractive surface, or the magnifier comprises a diffractive surface which is separate from the first and second surfaces.
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15. The optical system of Claim 14 wherein:

$$f_1/f_0 > 1.3.$$

16. The optical system of Claim 14 wherein the diffractive surface is closer to the magnifier's long conjugate side than to its short conjugate side.

15 17. The optical system of Claim 16 wherein the first surface is the diffractive surface.

18. The optical system of Claim 17 wherein the first surface is both diffractive and aspheric.

19. The optical system of Claim 14 wherein the first and second surfaces are aspheric.
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20. The optical system of Claim 14 wherein the magnifier is telecentric on its short conjugate side.

21. The optical system of Claim 14 wherein the first element, the block of optical material, and the second element are molded as one solid piece.

25 22. The optical system of Claim 14 wherein the optical path through the block of optical material is folded.

23. The optical system of Claim 14 wherein the distance T between the first and second surfaces satisfies the relationship:

$$30 \text{ millimeters} \leq T \leq 45 \text{ millimeters}.$$

30 24. An optical system comprising:

(A) a microdisplay; and

(B) a magnifier for producing a magnified image of the microdisplay for viewing by a human eye, said magnifier having a focal length f_0 , a long conjugate side in the direction of the human eye, and a short conjugate side in the direction of the microdisplay, said magnifier, in order from the long conjugate side to the short conjugate side, comprising:

(I) a first element having a first surface which is convex in the direction of the long conjugate, said first element having a focal length f_1 ;

(II) a block of optical material; and

(III) a second element having a second surface which is convex in the direction of the short conjugate, said second element having a focal length f_2 ;

wherein:

(a) $f_1 > 0$;

(b) $f_2 > 0$;

(c) $f_1/f_0 > 1.3$; and

(d) the first surface is a diffractive surface, or the second surface is a diffractive surface, or the magnifier comprises a diffractive surface which is separate from the first and second surfaces.

25. The optical system of Claim 24 wherein the diffractive surface is closer to the magnifier's long conjugate side than to its short conjugate side.

26. The optical system of Claim 25 wherein the first surface is the diffractive surface.

27. The optical system of Claim 26 wherein the first surface is both diffractive and aspheric.

28. The optical system of Claim 24 wherein the first and second surfaces are aspheric.

29. The optical system of Claim 24 wherein the magnifier is telecentric on its short conjugate side.

30. The optical system of Claim 24 wherein the first element, the block of optical material, and the second element are molded as one solid piece.

31. The optical system of Claim 24 wherein the optical path through the block of optical material is folded.

32. The optical system of Claim 24 wherein the distance T between the first and second surfaces satisfies the relationship:

5 $30 \text{ millimeters} \leq T \leq 45 \text{ millimeters}.$

33. An optical system comprising:

(A) a microdisplay; and

(B) a magnifier for producing a magnified image of the microdisplay for viewing by a human eye, said magnifier having a long conjugate side in the direction of the human eye, a short conjugate side in the direction of the microdisplay, and, in order from the long conjugate side to the short conjugate side, comprises:

(I) a first element having a first surface which is convex in the direction of the long conjugate, said first element having a focal length f_1 ;

(II) a block of optical material; and

15 (III) a second element having a second surface which is convex in the direction of the short conjugate, said second element having a focal length f_2 ;

wherein:

(a) $f_1 > 0$;

(b) $f_2 > 0$; and

20 (c) the magnifier comprises a diffractive surface which is closer to the magnifier's long conjugate side than to its short conjugate side.

34. The optical system of Claim 33 wherein the first surface is the diffractive surface.

35. The optical system of Claim 34 wherein the first surface is both diffractive and aspheric.

36. The optical system of Claim 33 wherein:

(a) the block of optical material has a long conjugate surface ;

(b) the first element has a long conjugate surface and a short conjugate surface, the long conjugate surface being the first surface;

(c) the short conjugate surface of the first element is spaced from the long conjugate surface of the block of optical material; and

(d) the short conjugate surface of the first element or the long conjugate surface of the block of optical material is the diffractive surface.

5 37. The optical system of Claim 33 wherein the first and second surfaces are aspheric.

 38. The optical system of Claim 33 wherein the magnifier is telecentric on its short conjugate side.

10 39. The optical system of Claim 33 wherein the first element, the block of optical material, and the second element are molded as one solid piece.

 40. The optical system of Claim 33 wherein the optical path through the block of optical material is folded.

 41. The optical system of Claim 33 wherein the distance T between the first and second surfaces satisfies the relationship:

15 $30 \text{ millimeters} \leq T \leq 45 \text{ millimeters}.$